METHOD AND APPARATUS FOR ROTATING AUTO RESERVE AGENTS BASED ON OCCUPANCY

FIELD OF THE INVENTION

5   The present invention relates to the duty assignment of agents associated with an

enterprise. In particular, the present invention relates to the automatic reservation of

agents to handle work related to particular skills based on the occupancies of the agents.

BACKGROUND OF THE INVENTION

Various systems have been developed to allocate work among agents associated

10   with an enterprise. For example, automatic call distribution systems are available that are

capable of distributing calls to call handling agents according to some predefined criteria.

If a call arrives and there is no available agent, the call is placed in a queue to await an

available agent. Likewise, if an agent becomes available for a call or queue and there is

no call waiting for service, the agent is placed in a queue to await the arrival of a call.

15   In order to improve the efficiency with which calls are handled, calls and agents

are typically segregated according to defined skills. In particular, calls that require a

particular agent skill to handle are preferably placed in call queues that are serviced by

agents having that agent skill. Although such systems can increase customer satisfaction

with respect to the accuracy with which a call is handled, problems in efficiently

20   allocating agents to service the various queues can be created.

In order to ensure that service level targets are met with respect to call queues,

systems may act to move agents from queues in which service level targets are being met

to underserved queues. In particular, such systems can automatically reserve agents to

receive work from a particular queue. Although such techniques can help meet service

level targets with respect to a particular queue, inequalities in the distribution of work among individual agents can result.

In order to address the equitable allocation of work to agents, systems have distributed calls to agents in inverse order of their individual occupancies. However, this

5 approach does not address inequalities between the workloads of agents assigned to different call queues. For example, because automatic call distribution systems have not limited the number of agents that can be reserved to receive calls from a particular call queue to any administered maximum, agent queues having very low agent occupancies can develop, even though other agent queues from the same system have comparatively

10 high agent occupancies. The inability of such systems to allocate work loads equally among agents results in different agents being required to perform different amounts of work, and/or does not fairly allocate the opportunity to earn commissions among agents.

SUMMARY OF THE INVENTION

The present invention is directed to solving these and other problems and

15 disadvantages of the prior art. According to the present invention, each agent queue associated with a particular agent skill is assigned a maximum number of agents that can be reserved for the skill. When an agent having a first agent skill becomes available, that agent may be reserved to serve only the first agent queue associated with the first agent skill, if the assigned maximum number of agents for the agent queue has not been

20 reached. If the assigned maximum number of agents reserved for the first agent queue has been reached, the available agent may, under certain circumstances, replace an agent already reserved to service calls or requests for service that are associated with the first skill and that are therefore directed to the first queue for service.

In accordance with an embodiment of the present invention, an agent having only a first skill may replace an agent having multiple skills that is already reserved in an agent queue associated with the first skill. In accordance with another embodiment of the present invention, an agent having multiple skills, including a first skill, that becomes

5 available may replace another agent having multiple skills that is already assigned to an agent queue associated with the first skill if the agent already reserved for the agent queue has a lower occupancy than the available agent. If a number of agents have a lower occupancy than the available agent, the agent having the lowest occupancy is released from the queue and is replaced by the available agent.

10 The process of detecting available agents and assigning such agents to queues requiring skills possessed by the available agent can be performed continuously. Accordingly, agents may be efficiently allocated among queues based on their skills in realtime. In addition, the work loads or occupancies of individual agents are assessed to assist in distributing equal amounts of work to individual agents.

15 These and other advantages and features of the present invention will become more apparent from the following description of illustrative embodiments of the invention, taken together with the drawings.

<div align="center">BRIEF DESCRIPTION OF THE DRAWINGS</div>

Fig. 1 is a block diagram of a call center that includes an illustrative embodiment

20 of the present invention;

Fig. 2 is a flow diagram illustrating a process for establishing agent queues and a maximum number of agents reserved for each queue in accordance with an embodiment of the present invention;

Fig. 3 is a flow diagram illustrating a process for allocating agents in accordance with an embodiment of the present invention;

Fig. 4 is a flow diagram illustrating the assignment of an agent having a single skill to a call queue in accordance with an embodiment of the present invention;

5   Fig. 5 is a flow diagram illustrating the assignment of an agent having multiple skills to a call queue in accordance with an embodiment of the present invention; and

Fig. 6 is a flow diagram of the operation of a system in allocating an agent to a call queue in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

10   Fig. 1 is a block diagram of an illustrative call center, such as may be used in accordance with embodiments of the present invention. The call center comprises a plurality of telephone lines and/or trunks 100 selectively interconnected with a plurality of agent positions 102-104 via an automatic call distribution (ACD) system 101. Each agent position 102-104 includes a voice and data terminal 105 for use by a corresponding

15   agent 106-108 in handling calls. Terminals 105 are connected to the ACD system 101 by a voice and data transmission medium 109. Also connected to ACD system 101 is a conventional call management system (CMS) 110 that gathers call records and call center statistics for use in managing the call center and in generating call center reports.

ACD system 101 is illustratively the MultiVantage™ Enterprise Communications

20   System based ACD system available from Avaya Inc. It is a stored program controlled system that conventionally includes interfaces to external communications links, a communications switching fabric, service circuits (e.g., tone generators, announcement circuits, etc.), memory 160 for storing control programs and data, and a processor 161 for

executing the stored control programs to control the interfaces and the fabric and to

provide automatic call-distribution functionality. Included among the data stored in the

memory **160** of ACD system **101** are a set of call queues **120** and a set of agent queues

130. Each call queue **121-129** corresponds to a different agent skill, as does each agent

5   queue **131-139**. Accordingly, for each call queue **121-129** there typically exists a

corresponding agent queue **131-139**, forming a queue pair. However, such a one-to-one

correspondence between call queues **121-129** and agent queues **131-139** is not necessary.

Conventionally, calls are prioritized, and either are enqueued in individual ones of call

queues in their order of priority or are enqueued in different ones of a plurality of call

10   queues that correspond to a skill and each one of which corresponds to a different

priority. Included among the control programs in the ACD system **101** is a call vector

140 that assigns calls incoming on lines or trunks **100** to different call queues **121-129**

based upon the agent skill or skills that they require for their proper handling.

Furthermore, a call may be handled by agents having different skills, and therefore may

15   be assigned to multiple call queues **121-129** simultaneously, most likely at different

priorities. If an agent is not immediately available to handle an incoming call, the call

will be held in the assigned call queue or queues **121-129**. If a number of agents are

available, the call may be handled by the agent in the appropriate agent queue with the

lowest occupancy, or according to some other criterion.

20   In general, agents **106-108** who are available for handling calls are assigned to

agent queues **131-139** based upon the skills that they possess. An agent may have

multiple skills, and therefore may be assigned to multiple agent queues **131-139**

simultaneously. In addition, in accordance with an embodiment of the present invention,

an agent may be reserved for a particular agent queue or queues **131-139**, so that the agent is only assigned calls or other work associated with the agent queue or queues **131-139** for which they are reserved. In particular, in accordance with embodiments of the present invention, agents having a particular skill that become available may be reserved

5   to an agent queue **131-139** associated with that skill until a target service level is reached, or until a selected maximum number of agents defined for the queue has been reached. In addition, the present invention allows an agent assigned to and reserved for a particular agent queue **131-139** to be replaced by an available agent based on an assessment of agent skills and occupancy, as described more fully below.

10   With reference now to **Fig. 2**, a process for establishing call queues and agent queues and a maximum number of agents reserved for each queue is illustrated. Initially, at step **200**, call queues and agent skills associated with each call queue, and agent queues and agent skills associated with each agent queue, are defined. In general, the number of call queues **123-129**, agent queues **131-139**, and agent skills defined in connection with a

15   system depend, at least in part, on the size and complexity of the system. For example, where a call center is established in connection with an enterprise having a wide range of operations, or where the call center is involved in servicing a number of disparate enterprises, a relatively large number of call queues and agent skills may be defined. For call centers handling relatively small volumes of calls or that handle a relatively narrow

20   range of topics, a smaller number of call queues and agent skills may be defined.

At step **204**, a value setting the maximum number of agents that can be automatically reserved to receive calls placed in a first call queue (i.e., that can be reserved for a particular agent queue **131-139**) is selected. In general, the allocation of

agents to agent queues **131-139** can be more closely controlled using the present

invention as compared to other approaches, because of the ability to specify a maximum

number of reserved agents for each queue. In particular, while other systems will reserve

available agents to a queue so long as a target service level associated with the queue has

5   not been met, the present invention ensures that the number of agents reserved for a

particular agent queue **131-139** is limited. In addition, it should be appreciated that, in

accordance with an embodiment of the present invention, the selected maximum number

of reserved agents can be zero. If the selected maximum number of agents reserved for a

particular queue is zero, agents will not be held in reserve to await calls associated with

10   that queue.

At step **208**, a determination is made as to whether a value setting the maximum

number of automatically reserved agents has been selected for each agent queue. If a

value setting the maximum number of automatically reserved agents has been selected for

each agent queue, the process ends (step **212**). If a value setting the maximum number of

15   automatically reserved agents has not been selected for each agent queue, the next agent

queue is obtained (step **216**) and a value setting the maximum number of agents that can

be automatically reserved for the agent queue is selected (step **220**). The process then

returns to step **208**.

With reference now to **Fig. 3**, a process for determining the skills possessed by

20   each agent associated with a system and for allocating those agents to agent queues **131-**

139 in accordance with an embodiment of the present invention is illustrated. Initially, at

step **300**, the agent skills for the agent under consideration are determined. As can be

appreciated by one of skill in the art, one or more agent skills may be associated with

each agent. In general, an agent skill is defined as a particular qualification or set of

qualifications that are required in order to perform work, such as servicing calls, of a

particular type. For example, a first agent skill may be defined in connection with

handling calls from customers regarding a first topic, while a second agent skill may be

5   defined in connection with handling calls from customers regarding a second topic. At

step **304**, a determination is made as to whether skills for all agents associated with the

system have been determined. If agents for whom skills have not been determined

remain, the next agent is obtained (step **308**) and the process returns to step **300**, at which

point skills for that next agent are determined.

10   If skills for all agents associated with the system have been determined, the

process next determines whether an agent has become available (step **310**). In general, an

agent becomes available when the agent initially logs into the system, or after an agent

has completed an assigned work item. Upon an agent becoming available, the automatic

reservation process for the available agent is started (step **312**). Steps that may be taken

15   in connection with automatic reservation processes in accordance with embodiments of

the present invention are discussed in detail in connection with **Figs. 4, 5** and **6** of the

present disclosure.

           After the automatic reservation process for the available agent has been started, or

if no agent is currently available, a determination is made as to whether a new agent has

20   been added to the system (e.g., has signed into the system) (step **316**). If a new agent has

been added to the system, the process returns to step **300**. If a new agent has not been

added to the system, the system returns to step **310**. Accordingly, it can be appreciated

that the process of determining agent skills and performing automatic reservation

processes with respect to agents can be performed continuously.

With reference now to **Fig. 4**, a process for automatically reserving an available

agent having a single agent skill in accordance with an embodiment of the present

5   invention is illustrated. Initially, at step **400**, an agent with a single associated skill

becomes available. At step **404**, a determination is made as to whether the agent skill

held by the available agent is an auto reserve skill. A skill is an auto reserve skill if

available agents are automatically reserved for servicing calls associated with the agent

skill under consideration. As an example, a skill may be placed in auto reserve, and thus

10   be an auto reserve skill, if service target levels for the skill are not being met. If the

subject agent skill is not in auto reserve, the agent is made generally available (step **408**).

If the subject skill is in auto reserve, a determination is made as to whether the

selected maximum number of agents have already been reserved for the agent queue

associated with the skill (step **412**). If it is determined that the selected maximum

15   number of agents that can be reserved for the agent queue has not been reached, the agent

reserved count is incremented, and the agent is made available to receive calls from the

call queue associated with the agent queue for the subject skill (step **416**). According to

an embodiment of the present invention, the number of agents reserved count is

decremented for a skill if an agent that had been reserved for the skill takes a call,

20   changes state, or otherwise becomes unavailable.

If the maximum number of agents that can be reserved for the agent queue

associated with the subject skill has been reached, a determination is made as to whether

any multi-skilled agents have been automatically reserved for the agent queue (step **420**).

That is, a determination is made as to whether there are any multi-skilled agents that are presently in the agent queue established in connection with the subject agent skill. If there are no multi-skilled agents currently assigned to the agent queue, the first agent is made available generally (i.e., the first agent is not automatically reserved for the agent

5   queue associated with the subject agent skill) (step **424**).

If there are any multi-skilled agents reserved for the agent queue, the first agent is made available and is reserved for the first agent queue (step **428**). Also at step **428**, the multi-skilled agent in the first agent queue is released (i.e., is no longer reserved for the first agent queue and is made generally available). Where a number of multi-skilled

10   agents have been reserved for the first agent queue, the multi-skilled agent having the lowest occupancy is released. Accordingly, embodiments of the present invention may continually or periodically update the occupancy associated with each agent. As can be appreciated by one of skill in the art, an agent's occupancy can be defined by the ratio between the agent's total time at work (i.e., staffed) and the actual time that the agent has

15   spent working.

With reference now to **Fig. 5**, a process in accordance with an embodiment of the present invention for automatically reserving an agent having multiple skills that becomes available is illustrated. Initially, at step **500**, a first agent having multiple skills becomes available. At step **504**, a determination is made as to whether every agent skill

20   associated with the first agent has been checked. If the determination is that every skill has not been checked, a next (e.g., a first) skill is obtained (step **508**). At step **512**, a determination is made as to whether the agent queue associated with the currently

selected skill is in auto reserve. If the skill is not in auto reserve, the process returns to step **504**.

If the subject skill is in auto reserve, a determination is made as to whether the selected maximum number of agents that can be reserved in connection with the subject

5   skill has been reached (**516**). If the selected maximum number has not been reached, the first agent is marked for automatic reservation into the subject skill, and the count of agents reserved for the skill in incremented (step **520**). The process may then return to step **504**. In accordance, with an embodiment of the present invention, the count of agents reserved for a skill is decremented when an agent that had been reserved for the

10   skill takes a call, changes state, or otherwise becomes available.

If the selected maximum number of agents has been reached, a determination is made as to whether any multi-skilled agents having a lower occupancy than the agent under consideration are currently reserved for the skill (step **524**). If no multi-skilled agent having a lower occupancy (or no multi-skilled agent) is reserved for the skill, the

15   agent under consideration is not marked for automatic reservation into the skill, and the process returns to step **504**.

If any multi-skilled agent having a lower occupancy than the agent under consideration is reserved for the skill, the agent under consideration is marked auto-reserved for the skill, and the multi-skilled agent having a lower occupancy is released

20   (step **528**). In addition, if there are a number of multi-skilled agents having a lower occupancy than the agent under consideration, the multi-skilled agent with the lowest occupancy is released. As an alternative to releasing an agent or agents having a lower occupancy than the agent under consideration, the agent or agents having the fewest skills

are released from auto reserve, if the agent under consideration has more auto-reserved

skills. The system then returns to step **504**.

If at step **504** it is determined that every agent skill associated with the system has

been checked, a determination is next made as to whether the agent under consideration

5   has been marked auto-reserved with respect to any agent skill (*i.e.* with respect to any

agent queue)(step **532**). If the agent under consideration has not been automatically

reserved for any skill, the agent is made available with respect to all of the agent's skills,

or to perform work that does not require any particular skill (step **536**). If the agent under

consideration has been marked as auto-reserved with respect to any skill, the agent is

10   made available in all skills for which that agent has been automatically reserved, and is

not made available in skills that are not auto-reserved (step **540**).

From the above description, it can be appreciated that a multi-skilled agent can be

simultaneously reserved with respect to more than one agent skill. That is, a multi-skilled

agent may be placed in more than one agent queue simultaneously. This feature of

15   embodiments of the present invention allows agent occupancy to be maximized. In

addition, such an embodiment of the present invention allows multi-skilled agents having

a low occupancy to be released from an agent queue to perform other work.

With reference now to **Fig. 6**, the operation of a system for automatically

reserving agents to perform work in connection with an embodiment of the present

20   invention is illustrated. In particular, **Fig. 6** illustrates an example of how a system in

accordance with an embodiment of the present invention can continually reserve and

release single and multi-skilled agents to help ensure the efficient use of available agent

skills, and to equalize the occupancies of agents. Initially, at step **600**, a first agent

becomes available. At step **604**, a determination is made as to whether every agent skill

associated with the first agent has been checked. If skills remain to be checked, the next

(e.g., the first) skill is obtained (step **608**).

At step **612**, a determination is made as to whether the skill currently under

5   consideration is in auto reserve. If the skill is not in auto reserve, the process returns to

step **604**.

If the skill under consideration is below the service target, a determination is next

made as to whether a selected maximum number of agents for the skill have been

reserved (step **616**). If the selected maximum number of agents has not been reached, the

10   first agent is marked auto reserved in the subject skill (*i.e.*, the agent is marked auto-

reserved for the associated agent queue), and the agents reserved count for this skill is

incremented (step **620**). According to an embodiment of the present invention, if an

agent assigned to a skill takes a call, changes state, or otherwise becomes unavailable, the

agents reserved count for the skill is decremented. The process then returns to step **604**.

15   If the maximum number of agents for the skill has been reserved, a determination

is next made as to whether the first agent is a single-skilled agent (step **624**). If the first

agent is not a single-skilled agent, a determination is made as to whether any multi-

skilled agents having a lower occupancy than the first agent have been reserved with

respect to the subject skill (step **628**). If no multi-skilled agent having a lower occupancy

20   than the first agency is found, the system returns to step **604**.

If a multi-skilled agent having a lower occupancy is currently reserved for the

subject skill, the first agent is marked auto-reserved for the subject skill, and the multi-

skilled agent having a lower occupancy is released to perform other work (step **632**).

Where a number of multi-skilled agents are currently reserved for the subject skill, the multi-skilled agent having the lowest occupancy is released from the agent queue for the subject skill. The system then returns to step **604**.

If at step **624** it is determined that the first agent is a single-skilled agent, a

5   determination is next made as to whether any multi-skilled agents are currently automatically reserved (step **636**). If multi-skilled agents are auto reserved for the subject skill, the first agent is marked auto reserved and the multi-skilled agent is released to perform other work (step **632**). Again, if a number of multi-skilled agents are currently reserved, the multi-skilled agent having the lowest occupancy is released to perform other

10   work at step **632**. After replacing a multi-skilled agent with the single-skilled agent at step **632**, or if no multi-skilled agents have been auto reserved for the subject skill, the system returns to step **604**.

If at step **604** it is determined that every agent skill associated with the first agent has been checked, a determination is next made up as to whether the first agent has been

15   marked for automatic reservation into any of the skills (step **640**). If the first agent has not been marked for automatic reservation into any skill, the agent is made available with respect to all of the agent's skills (step **644**). For example, even though the first agent may not have been reserved for handling calls sent to a specific call queue, the agent may nonetheless be assigned to service such a call as a result of conventional call distribution

20   functions included in the system.

If at step **640** it is determined that the first agent has been marked for automatic reservation into any skill, the first agent is reserved with respect to all such skills (i.e., the

agent is reserved for each agent queue corresponding to each agent skill for which the

first agent has been marked reserved) (step **648**).

In addition, embodiments of the present invention may auto reserve an agent

having a single skill in place of a single-skilled agent already reserved for the agent

5   queue corresponding to the agent skill where the occupancy of the reserved agent is less

than that of the available agent, and where there are no multi-skilled agents that can be

replaced by the available agent.

Although the foregoing description has used as examples a system comprising a

call center staffed by human agents, it should be appreciated that the present invention is

10   not so limited. For example, embodiments of the present invention may be utilized in

connection with the reservation of any resource to perform work of a particular type.

Furthermore, it should be appreciated that the present invention, while particularly useful

in connection with the reservation and release of agents in real-time, may be utilized in

connection with systems in which agents may be reserved to particular queues for

15   extended periods of time. For example, in addition to substantially real-time call

distribution system applications, the present invention may be applied to systems used to

distribute work items comprising textual correspondence to resources for action and

possible reply. Embodiments of the present invention are also not limited to operation on

a switch. For example, embodiments of the present invention may be implemented as a

20   separate application.

The foregoing discussion of the invention has been presented for purposes of

illustration and description. Further, the description is not intended to limit the invention

to the form disclosed herein. Consequently, variations and modifications commensurate

with the above teachings, within the skill and knowledge of the relevant art, are within

the scope of the present invention. The embodiments described hereinabove are further

intended to explain the best mode presently known of practicing the invention and to

enable others skilled in the art to utilize the invention in such or in other embodiments

5   and with various modifications required by their particular application or use of the

invention. It is intended that the appended claims be construed to include the alternative

embodiments to the extent permitted by the prior art.